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Inflation Dynamics and the New Keynesian Phillips Curve*

BY KEITH SILL

A 1977 amendment to the Federal Reserve Act states that the Fed's mandate is "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Moderate long-term interest rates require low and stable inflation. Monetary policymakers use instruments such as a short-term interest rate to guide the economy with the aim of achieving an inflation objective. To help guide their decisions, monetary policymakers benefit from having a reliable theory of how inflation is determined, one that relates the setting of their instrument to the unexpected events that hit the economy and consequently to the rate of inflation and other economic variables. In this article, Keith Sill examines a prominent theory of how inflation is determined, as articulated in what is called the New Keynesian Phillips curve. He also investigates some of the implications of the theory for the conduct of monetary policy.

Policymakers, economists, and the public generally agree that low and stable inflation is beneficial to the economy. Low and stable inflation makes it easier for households to plan their savings and investments and for firms to make production and investment decisions. It also helps to promote equity across members of society, since low-income households often do not have access to the financial instruments that help guard savings from being eroded by inflation.[1] Also, households and firms often write contracts that are stated in dollar amounts (nominal terms). A worker may, for example, sign a contract to work over the upcoming year for a fixed dollar amount. If inflation turns out to be higher than what was expected at the time the contract was made, the worker may find he is unable to purchase as many goods and services as planned because his inflation-adjusted income is lower than expected. Stable inflation would help mitigate such problems.

A 1977 amendment to the Federal Reserve Act codified the importance of low and stable inflation as a goal for monetary policymakers. The amendment states that the Fed's mandate is "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Moderate long-term interest rates require low and stable inflation, on average. But how does the Fed control inflation? It cannot simply dictate that the rate of price increase will be, say, 2 percent. Rather, monetary policymakers use instruments such as a short-term interest rate to guide the economy with the aim of achieving an inflation objective. To help guide their decisions, monetary policymakers benefit from having a reliable theory of how inflation is determined: a theory that relates the setting of their instrument to the unexpected events

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*The views expressed here are those of the author and do not necessarily represent the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System.

[1] See the April 2007 speech by then-Governor Frederic S. Mishkin.

that hit the economy and consequently to the rate of inflation and to other economic variables of interest. With such a model in hand, policymakers can make informed decisions about the likely course of inflation and how to set an instrument such as the federal funds rate to achieve their inflation objectives.

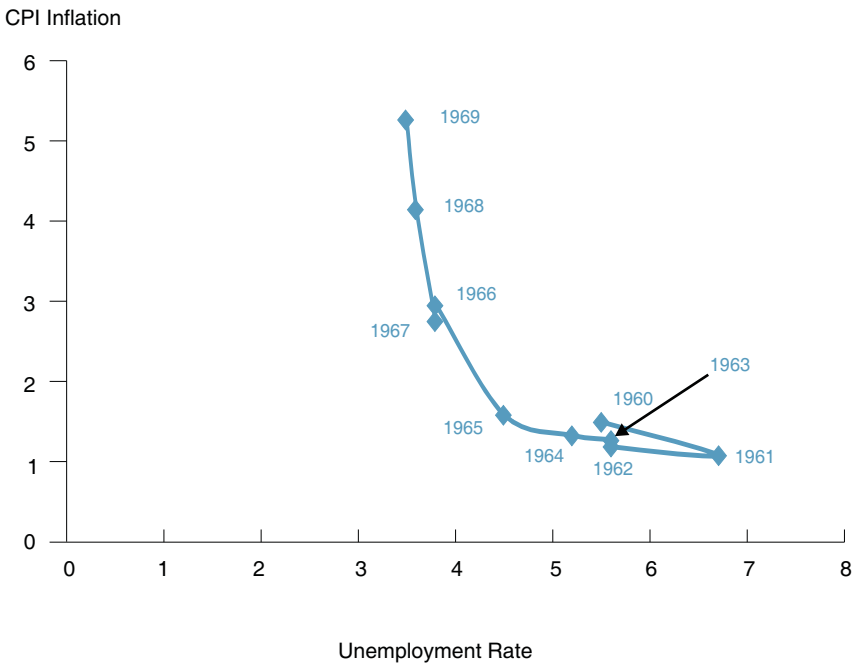
In this article, we will examine a prominent theory of how inflation is determined, as articulated in what is called the New Keynesian Phillips curve. The theory ties current inflation to expected future inflation, a measure of firms' cost of production, and shocks that hit the economy. When embedded in a larger model of the economy that determines how inflation expectations are formed, the theory gives guidance to policymakers on how to meet their inflation goals. Consequently, we will also investigate some of the implications of the theory for the conduct of monetary policy.

A LITTLE HISTORY: INFLATION AND EMPLOYMENT

There is a long and storied history in macroeconomics about the relationship between inflation and real economic activity. In 1958, William Phillips wrote a paper on the empirical relationship between wage inflation and unemployment in the U.K. over the period 1861-1957. Phillips observed that when wage inflation was high, the unemployment rate tended to be low, and vice versa. This inverse empirical relationship seemed to suggest that there might be a stable, permanent tradeoff between wage inflation, or price-level inflation more generally, and the unemployment rate. If so, policymakers could stimulate the economy and lower the unemployment rate at the expense of somewhat higher inflation. Indeed, for the U.S. economy, there appeared to be a stable tradeoff between inflation and the unemployment rate in the 1960s (Figure 1).[2]

FIGURE 1

Phillips Curve in the 1960s



Unfortunately, the Phillips curve turned out to be not as stable as was first believed. The 1970s were a decade during which the economy experienced both high inflation and high unemployment rates, a development that came to be known as stagflation. Indeed, examining the entire span of data from the 1960s to the present, it is difficult to discern a tradeoff between inflation and unemployment. Rather than a negative one, the relationship between inflation and unemployment does not appear to be stable, and if anything, there seems to be a positive relationship between inflation and the unemployment rate (Figure 2).[3] Clearly, the relationship between the unemployment rate and inflation is not as simple as was first believed.

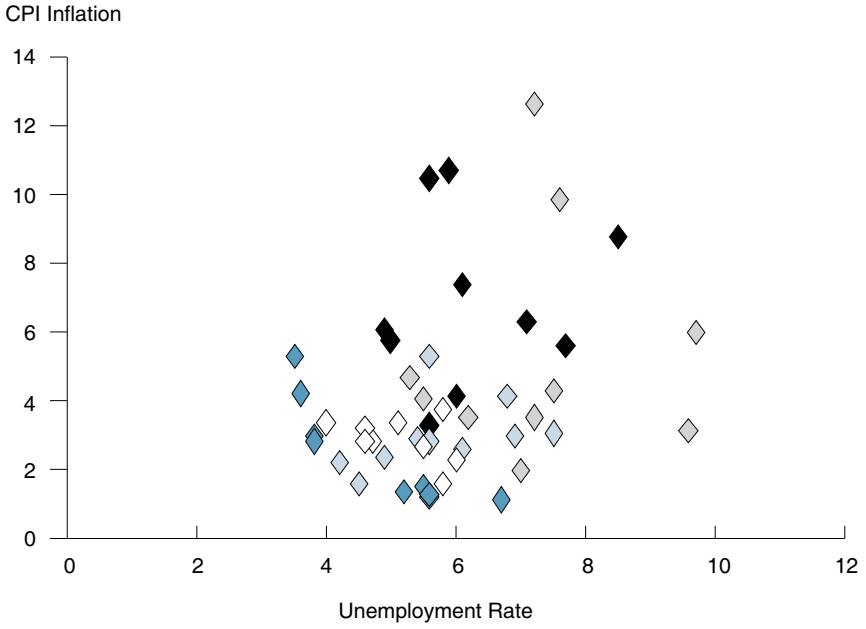
A key insight into the problem with the original Phillips curve's implication of a tradeoff between inflation and unemployment was made by Milton Friedman in his presidential address at the American Social Sciences Association meeting in 1968. Friedman observed that although the original Phillips curve traced out a relationship between money wages and the unemployment rate, what workers

[2] The relationship between inflation and the unemployment rate was an especially tight one in the 1960s. For another perspective on the Phillips curve that uses a longer history of data, see Figure 1, in Roc Armenter's article. See also the article by Jeffrey Lacker and John Weinberg for an accessible discussion of inflation, unemployment, and the Phillips curve.

[3] The episode of high inflation together with high unemployment during the 1970s (the black dots in Figure 2) came to be known as "stagflation." This period led to the recognition that the Phillips curve might not be stable. See Armenter's article for additional discussion.

FIGURE 2

Inflation and Unemployment 1960-2008



Color coded by decade: 1960s blue, 1970s black, 1980s gray, 1990s white, 2000s light blue

really cared about was their real wage — the wages they were paid relative to the prices they paid for goods and services. This implies that workers care about the expected rate of price increase, or inflation. If everyone expected prices to rise by 10 percent over the coming year, workers would try to negotiate a wage contract that called for at least a 10 percent increase in wages so that, in real terms, they would not be any worse off. Firms would be happy to pay the 10 percent increase because the real cost of labor is unchanged. Consequently, firms would not have an incentive to change employment. One would then expect to see money wages rising by 10 percent with no accompanying decrease in the unemployment rate. The implication is that in the long run, when expectations about price increases are factored in, there should be no exploitable tradeoff between inflation and unemployment.

Note, though, that if inflation turns out to be different than expected, the situation changes. If inflation rises by 15 percent when workers thought it would rise by 10 percent, workers would experience a decline in their inflation-adjusted wages and so would wish they had worked less. On the other hand, firms would have liked to hire additional workers at the lower real wage. If we assume that firms prevail and hire more workers at the existing wage, employment would increase, unemployment would decrease, and we get the Phillips curve relationship. But if expectations are correct, that inverse relationship between unemployment and inflation breaks down.

The view that a stable, inverse relationship between the unemployment rate and inflation disappears once a role for inflation expectations is introduced has gained support from empirical work that tries to predict future inflation using measures of economic activity such as the unemployment rate. The traditional Phillips curve suggests that inflation is related to the unemployment rate (actually its deviation from the economy's normal rate of unemployment). The implication of that theory is that unemployment rates will help to predict future inflation. Statistical analysis indicates that prior to the 1980s, such a relationship appeared to hold in the data: Measures of economic activity such as unemployment rates or fluctuations in output did help predict future inflation.[4] However, since the end of the 1970s, this no longer seems to be the case. Indeed, using data from 1980 onward, it appears that simply predicting that inflation in the next quarter will be what it is this quarter gives a forecast that is very hard to improve upon.[5] This finding is at least consistent with the view that inflation expectations are an important factor to consider when assessing the link between economic activity and inflation.

A NEW PHILLIPS CURVE

The traditional Phillips curve suggested that inflation and measures of economic activity were correlated, although the evidence for that theory now appears weak. Because the posited positive relationship between inflation and the unemployment rate

[4] Often, the output measure used is an output gap, which measures the deviations of real output from some proxy for potential real output, such as a long-term trend output. For more details about the output gap, see the article by Roc Armenter.

[5] See, for example, the papers by Andrew Atkeson and Lee Ohanian and James Stock and Mark Watson.

was based on historical correlations in the data, it faces several potential problems. For one, correlations in the data are likely to change if the structure of the economy changes. For example, if the Federal Reserve were to change the way it conducts monetary policy, it may well turn out that the correlation between inflation and economic activity in the data would change as well.[6] Indeed, such a change might be reflected in a shift in expected inflation. Furthermore, to predict how a change in monetary policy affects correlations in the data, we need a model of the economy that explicitly accounts for how the correlations among economic variables depend on the way monetary policy is set. With such a model in hand, the effects of a change in monetary policy (modeled as a change in the way policymakers respond to information) can be analyzed because the linkages between actions and outcomes are made explicit. One could then examine the model's predictions both before and after the monetary policy change to gauge the likely effects of the policy change on the economy. The key point is that simple correlations in the data are likely to change (and so become unstable) in response to a change in the fundamental structure underlying the economy.

We have also seen that the empirical evidence suggests that while the Phillips curve may have helped predict inflation prior to the 1980s, that relationship appears to have broken down since then. Obviously, models that predicted well in the past need not do so in the future, especially if there is a change in a fundamental factor such as monetary policy. To understand how structural changes to the economy affect empirical correlations, we need a theory of how the economic environment translates into correlations in the data.

The now dominant and workhorse model of monetary policy and business cycles is called the New Keynesian model. It is a structural model that delivers a theory of inflation that bears some resemblance to the traditional Phillips curve, but nonetheless, it has some significant differences. In principle, the model can help policymakers see how shocks to the economy and changes in the economic environment can translate into correlation in the data. In practice, however, this theory, like all economic theories, is a simplification of the actual economy and thus misses many potentially important linkages that are features of the real world. For example, the standard New Keynesian model does not have a well-developed financial sector and therefore has difficulty accounting for economic fluctuations prompted by financial crises.

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THE NEW KEYNESIAN PHILLIPS CURVE MODEL

The New Keynesian Phillips curve is derived from a structural model of the economy that features two key elements. First, firms have some pricing power. That is, they can choose to sell more of their product by setting a lower price, or they can choose to sell a little less but at a higher price. (This is known as imperfect competition.) Second, firms choose to, or are only able to, adjust prices infrequently (sticky prices). They do not adjust their prices fully and immediately to every unexpected event that affects the economy. These two features of the model allow monetary policy to affect more than just prices and inflation in the short run.

Imperfect Competition and Sticky Prices. Imperfect competition means that firms have some power over their price-setting. This contrasts with perfect competition, a situation in which firms have no power to set prices. For example, a farmer bringing wheat to the market will have to take the price offered by buyers; he has virtually no power to demand a price higher than the prevailing market price and hope to attract customers. This is, in part, because he represents a small part of the overall supply of wheat and, in part, because other suppliers of wheat are selling a similar, if not identical product. If the farmer raised his price above the market price, his product would go unsold.

Contrast this with a large firm, such as Honda, that represents a significant share of its market. Honda is a relatively large part of the automobile industry and offers products distinct from those offered by other automakers. Consequently, Honda can set a price for its cars and see what the quantity of cars demanded is at that price. If Honda wants to sell more cars, it can lower the price per car. If it wants more profit per car, it can raise the price. The key point is that Honda has some pricing power, and it can use that power to gauge market demand for a car at a particular price point.

Imperfect competition is an important feature of models that

[6] This is an example of the "Lucas critique." See the article by Robert E. Lucas.

embed a New Keynesian Phillips curve. It allows firms to set a price for their products. The second key component of the models is that although firms can choose the price they set, they can only do so infrequently. This means that at least some prices are unable to immediately adjust in response to the shocks hitting the economy.

Suppose that, contrary to the assumptions of the New Keynesian model, all firms were able to, and did, adjust their prices instantaneously in response to shocks. Then monetary policy would have little influence on the nonmonetary, real side of the economy — consumption, output, and investment. Instead, monetary policy would only be able to affect the general price level, even in the short run. To see this, suppose monetary policy is implemented using an interest rate policy, such as is done in the U.S. If the Fed raised the short-term nominal interest rate and prices adjusted instantly, the rise in the nominal interest rate would be matched by a rise in expected inflation that would keep the real interest rate unchanged.[7] With an unchanged real interest rate, households and firms have no incentive to change their planned consumption and investment, and so the real side of the economy would be unaffected. The Fed controls inflation by changing the amount of liquidity in the economy, but it cannot influence real economic activity.

Suppose, though, that not all prices adjusted instantly in response to an unexpected event that hits the economy or a change in the monetary policy interest rate. This could happen, for example, if contracts are written in nominal terms for a fixed duration or if firms face costs of adjusting the prices they charge. In addition to adjusting the general amount of liquidity in the economy, the Fed now has an additional channel through which to influence inflation. If prices are sticky, expected inflation will not rise one-for-one with an increase in the nominal interest rate and as a consequence the real interest rate would rise too. The rise in the real interest rate leads households to boost their savings, since the return to savings is higher (and so households cut back a little bit on their consumption). Similarly, with higher real interest rates, firms want to borrow less to fund investment, since the cost of funds is now higher (consequently investment falls). With less demand for consumption and investment, real output for the economy is lower. Thus, with sticky prices, a Fed-induced rise in the nominal interest rate is contractionary for the real economy, at least in the short run when some prices do not fully adjust.

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HOW IS INFLATION DETERMINED?

We can now put together the two pieces — imperfect competition and infrequent price adjustment — to show how inflation is determined in the structural model according to the New Keynesian Phillips curve. With imperfect competition, firms seek to maximize profit by setting a price that is marked up over the marginal cost of producing an additional unit of product. So, with imperfect competition we might find that firms maximize profits when they set their prices 20 percent higher than the marginal cost. If firms set prices below this optimal price, quantity demanded rises and revenue increases, but that increase is outweighed by the rise in production costs and profits fall. If they set prices above the optimal price, the quantity demanded falls and the decline in revenue outweighs the decline in production costs, so again profits fall.

Now consider the implications of infrequent price adjustment. Firms recognize that the price set today will prevail for some time; they will not be able to reset prices in response to every development in the economy. Consequently, a firm that is trying to figure out the optimal price to set today will want to take into account not only what today's marginal cost of production is but also what the marginal cost of production is likely to be for the entire time frame over which it expects the price to prevail. For example, if the firm anticipated that it would not reset its prices until one year from now, it would want to estimate what marginal costs would be over the next year when setting prices today.

Thus, the interaction of imperfect competition and infrequent price adjustment leads firms to set product prices taking into account the expected future behavior of marginal costs. This requires firms to project future expected demand, marginal cost, and

[7] The real interest rate is equal to the nominal interest rate less expected inflation. Consequently, it is the expected return to savings after accounting for expected inflation.

future price levels (or inflation). In the stylized model, the solution to this problem is that a firm sets a price that is its desired markup over a weighted average of current and expected nominal marginal costs.

How is aggregate inflation — the change in the overall level of prices between two periods — determined? The price level in this period will be a combination of prices set by firms that are adjusting prices today and of prices set by firms that are not adjusting their prices in this period. This means that the level of inflation is determined by the fact that firms that reset their prices today choose a different price from the one they charged yesterday. Since firms that reset prices set them as a markup over marginal cost, we find that when we add up across firms to get the economy-wide price level with which to calculate inflation, it must reflect the anticipated path of future real marginal cost for the economy as a whole. The mathematics of the New Keynesian Phillips curve allows us to express the deviation of inflation from its long-run expected value, as a weighted sum of three components: (1) the expected deviation of next period inflation from its long-run expected value; (2) the deviation of real marginal cost from its long-run expected value; and (3) an error term representing unexpected events that lead firms to change their markups over marginal cost.[8]

[8] Derivations of the New Keynesian Phillips curve can be found in many advanced macroeconomic textbooks and survey articles. For one such derivation, see the book by Jordi Gali listed in the references. The form of the New Keynesian Phillips curve is given by: $\pi_t = \beta E_t \pi_{t+1} + kmc_t + \varepsilon_t$ where π_t is the deviation of inflation from its expected long-run value, $E_t \pi_{t+1}$ is the expected value today of the deviation of inflation tomorrow from its long-run expected value, mc_t is the deviation of marginal cost from its long-run expected value, and ε_t represents unanticipated events that cause firms to change their markup.

IMPLICATIONS OF THE NEW KEYNESIAN PHILLIPS CURVE FOR INFLATION AND ECONOMIC ACTIVITY

Both the New Keynesian Phillips curve and the traditional Phillips curve provide theories of how inflation is determined. However, the two theories differ in the role they assign to expected inflation as a determinant of current inflation and in the nonmonetary economic variables that are the important drivers of inflation.

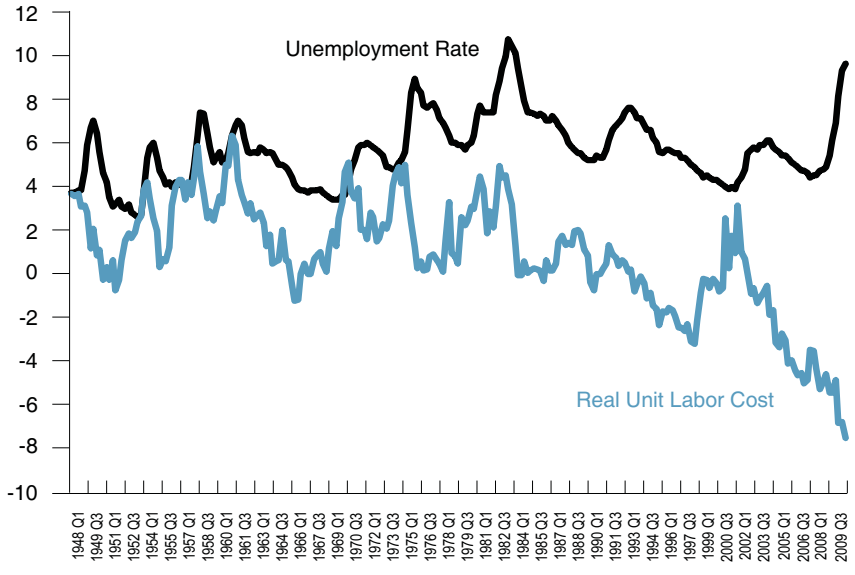
Consider first how the theories differ in the economic activity variable that drives short-run movements in inflation. The New Keynesian Phillips curve suggests that the short-run dynamics of inflation are driven by the expected path of marginal cost. But remember that in the traditional Phillips curve, it is the unemployment rate that is driving inflation. While it's at least conceivable that the unemployment rate is correlated with marginal cost and thus serves as a good empirical proxy, it turns out that, based on the empirical evidence, the unemployment rate does not appear to be highly correlated with measures of marginal cost.

Figure 3 presents some evidence on this. As shown, the unemployment rate and real unit labor cost, a measure of marginal cost, do not exhibit a great deal of co-movement. Indeed, the simple correlation between the two series is about zero. Under the New Keynesian Phillips curve model, looking at unemployment rates as indications of inflation pressure is not the obvious thing to do.[9]

[9] There could be a higher correlation between unit labor costs and an unemployment rate gap measure if we defined the gap in a way such that the difference between actual unemployment rates and the economy's normal rate of unemployment moves in the right way. But usually we think of the normal rate of unemployment as being a slow-moving object (which is itself subject to great measurement uncertainty). Consequently, it is unlikely that the unemployment rate gap is highly correlated with unit labor costs.

FIGURE 3

Unit Labor Cost and Unemployment Rate



Unit labor is defined as total labor compensation divided by real output. We then deflate unit costs by the GDP implicit price deflator to translate it into real terms and take logs (and scale up by a factor of 100).

The evidence on the correlation of output gaps, which are measures of the level of real output less a measure of the level of potential real output, with unit labor costs is a bit more nuanced. Figure 4 shows a plot of the Congressional Budget Office measure of the output gap and real unit labor costs. In this figure, though, we have removed long-run fluctuations from the data and we focus instead on fluctuations over the span of the typical business cycle's duration (which is eight years or less).[10] The figure shows that at this "business cycle frequency," the correlation was negative up until the 1990s. However, over the past 15 years or so the correlation looks positive.

This may be somewhat encouraging for the use of output gaps in accounting for inflation. But there are several important measurement issues with these series. First, economists disagree on the best way to measure the output gap and different methods give rise to very different estimates of the size of the gap at a point in time. Furthermore, we can extract information about fluctuations in a series over business cycle frequencies only long after the fact — real-time measures of the business cycle component of a series are highly uncertain.

Another important difference between the two versions of the Phillips curve is the role they assign to expected inflation as a determinant of movements in inflation today. A key feature determining inflation under the New Keynesian Phillips curve theory is the implication that inflation anticipates, or leads, measures of economic activity. Inflation responds to higher levels of expected marginal cost and so rises today in anticipation of that higher cost. In contrast, empirically estimated traditional Phillips curves are often specified to include lagged values of economic activity. Such a specification could be justified in the New Keynesian Phillips curve framework if the lagged values were useful for predicting marginal cost in the future.

It is important to note that the basic New Keynesian Phillips curve as described above does not imply a high degree of correlation over time in inflation rates: The inflation process is not very persistent. Indeed, there is no persistence over and above that which would be associated with marginal cost. As an empirical matter, though, there does appear to be more inflation persistence in the U.S. data than what would be implied by the baseline New Keynesian Phillips curve model.[11] One way in which persistence can be introduced into the model is to assume that prices are indexed to inflation. Thus, firms that don't re-optimize their prices in a given period nonetheless move their prices up with the general level of inflation that prevails in the economy. This is a bit of a shortcut, since we might reasonably ask why firms would not just take the time to set prices optimally, since they are going to reset them in line with inflation anyway.

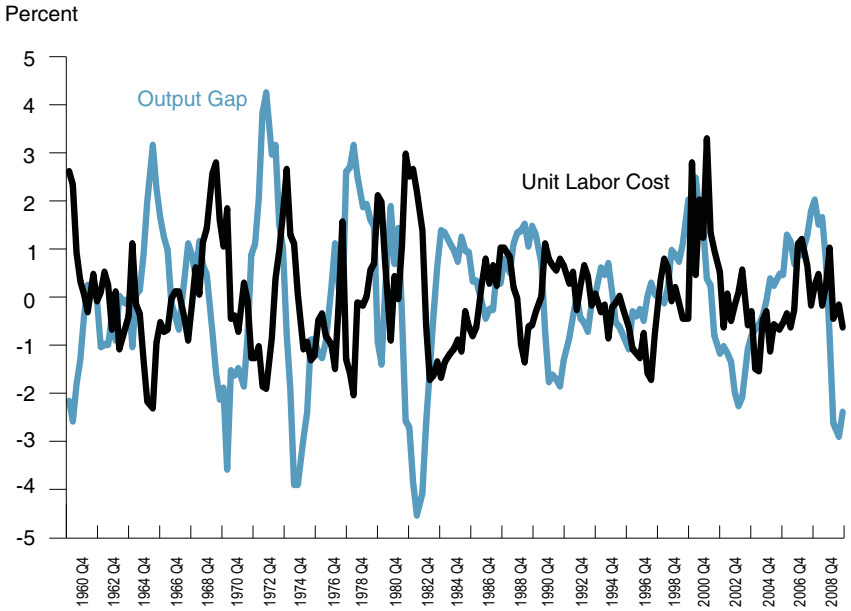
We can also introduce additional inflation persistence into the model by assuming that the expected long-run average rate of inflation changes slowly over time, as opposed to being constant. If the rate of inflation that policymakers are comfortable with changes over time, it would introduce a slow-moving component into the

[10] More technically, the plot shows the cycle component of the two series after the Hodrick-Prescott-filtered trend is removed from the data. The Hodrick-Prescott-filtered cycle represents fluctuations in the series at frequencies from zero to eight years.

[11] However, inflation persistence does not appear to be a pervasive feature of economies. See the paper by Luca Benati, who shows that the degree of inflation persistence varies across countries and within countries according to the monetary policy regime that is in place.

FIGURE 4

Output Gap and Unit Labor Costs



Output gap as measured by the Congressional Budget Office. Real unit labor costs are as described in the footnote to Figure 3. Both series are Hodrick-Prescott filtered, and the business cycle component is plotted.

inflation process and make actual inflation more persistent.[12]

MONETARY POLICY IMPLICATIONS OF THE NEW KEYNESIAN PHILLIPS CURVE: LESSONS AND CAVEATS

What can policymakers learn from the New Keynesian Phillips curve theory? One immediate implication is that unemployment rate gaps and output gaps should be used with caution when trying to assess inflation pressures in the economy. The theory implies that inflation is determined by expected future real marginal cost, and marginal cost does not appear to be highly correlated with unemployment rates or output gaps, as conventionally defined. Indeed, the paper by Jordi Gali and Mark Gertler argues that the New Keynesian Phillips curve with marginal cost as the measure of economic activity fits the data better than a traditional Phillips curve specification that uses output gaps.[13]

In addition to real activity measures, the New Keynesian Phillips curve suggests that expectations about the future are important for determining inflation today. For example, the theory indicates that monetary policy that is expected to be stimulative in the future can lead to higher inflation today. How does monetary policy end up being inflationary in this baseline model? Recall that inflation is given by the weighted sum of future real marginal costs. When monetary policymakers stimulate the economy by lowering interest rates, this action also stimulates demand. For firms to meet the higher demand, they must hire additional workers. Attracting additional workers requires a higher real wage — which raises the marginal cost of production for firms. Hence, firms that are re-optimizing their prices raise their prices today, and inflation ensues. The key point of contrast with the traditional Phillips curve model is that expectations of the future are an important component for inflation today.

Economic models that embed a New Keynesian Phillips curve tend to suggest that monetary policy can achieve about the best outcome possible when the policy interest rate responds aggressively to current or expected inflation: rising more than one-for-one when inflation rises, and falling more than one-for-one when inflation falls. The models also tend to suggest that the economy will be more stable if policymakers respond more aggressively to inflation developments than to developments in real activity such as unemployment rates and output gaps. The models do not suggest that developments in the real economy should necessarily be ignored, but policy should not respond too aggressively to them in a direct manner, since an aggressive policy response tends to promote further economic instability.[14]

Clearly, in the real world, monetary policymakers pay careful attention to developments in inflation and in output and employment. New Keynesian Phillips curve economic models make many simplifying assumptions, so their implications should be viewed with care. For example, firms' price-setting behavior, which, as we have seen, is a key component of the inflation process, is not very well understood and so is not modeled at a very deep level. The New Keynesian Phillips curve models tend to be at their most accurate when the economy is in "normal times" and behavior is not too far from average behavior. The models will not predict well, for example, in times of financial crisis, since the baseline New Keynesian model has no meaningful financial sector. This is not to suggest that New Keynesian Phillips curve models are not a useful part of the toolkit for monetary policymakers. They can help to clarify ideas about the transmission of shocks through the economy and point to likely determinants of economic variables such as inflation. However, empirically reasonable medium- and large-scale equilibrium models that embed the New Keynesian Phillips curve are at an early stage of development. Consequently, policymakers continue to be informed by a variety of models — both empirical and theoretical — as they consider how policy should best react to changes in the economy.

[12] This shows up in the New Keynesian Phillips curve as a persistent change in the long-run expected value of inflation. (Recall that the New Keynesian Phillips curve is an expression about the deviation of inflation from its expected long-run average value.)

[13] Note, though, that Galí and Gertler's study looked at the performance of the Phillips curve only up until the mid 1990s.

[14] See, for example, the article by Stephanie Schmitt-Grohe and Martin Uribe. In the standard New Keynesian model, targeting inflation helps to stabilize the impact of unexpected events on the economy and so leads indirectly to more stable output.

REFERENCES

Armenter, Roc. "Output Gaps: Uses and Limitations," Federal Reserve Bank of Philadelphia *Business Review* (First Quarter 2011).

Atkeson, Andrew, and Lee Ohanian. "Are Phillips Curves Useful for Forecasting Inflation?" Federal Reserve Bank of Minneapolis *Quarterly Review*, 25:1 (Winter 2001), pp. 2-11.

Benati, Luca. "Investigating Inflation Persistence Across Monetary Regimes," *Quarterly Journal of Economics* 123 (2008), pp. 1005-60.

Friedman, Milton. "The Role of Monetary Policy," *American Economic Review*, 58 (1968), pp. 1-17.

Galí, Jordi. *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework*. Princeton: Princeton University Press, 2008.

Galí, Jordi, and Mark Gertler. "Inflation Dynamics: A Structural Econometric Analysis," *Journal of Monetary Economics*, 44 (1999), pp. 195-222.

Lacker, Jeffrey, and John Weinberg. "Inflation and Unemployment: A Layperson's Guide to the Phillips Curve," Federal Reserve Bank of Richmond *Economic Quarterly*, 93 (2007), pp. 201-27.

Lucas, Robert E. "Econometric Policy Evaluation: A Critique," in K. Brunner and A.H. Meltzer, eds., *The Phillips Curve and Labor Markets*. Amsterdam: North-Holland, 1976, pp. 19-46.

Mishkin, Frederic S. "Monetary Policy and the Dual Mandate," speech (April 2007).

Phillips, A.W. "The Relationship Between Unemployment and the Rate of Change of Money Wages in the United Kingdom, 1861-1957," *Economica*, 25 (1958), pp. 283-99.

Schmitt-Grohe, Stephanie, and Martin Uribe. "Optimal Simple and Implementable Monetary and Fiscal Rules," *Journal of Monetary Economics*, 54 (2007), pp. 1702-25.

Stock, James, and Mark Watson. "Phillips Curve Inflation Forecasts," NBER Working Paper 14322 (September 2008).